PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re application of

Makoto KASHIWAYA, et al.

Appln. No.: 09/534,207

Confirmation No.: 2981

Filed: March 24, 2000

Docket No: Q55902

Group Art Unit: 1765

Examiner: DuyVu n Deo

For: CARBON LAYER FORMING METHOD

SUBMISSION OF APPELLANT'S BRIEF ON APPEAL

Commissioner for Patents
Washington, D.C. 20231

Sir:

Submitted herewith please find an original and two copies of Appellant's Brief on Appeal. A check for the statutory fee of $320.00 is attached. The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account. A duplicate copy of this paper is attached.

Respectfully submitted,

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APPELLANTS' BRIEF ON APPEAL UNDER 37 C.F.R. § 1.192

Commissioner for Patents
Washington, D.C. 20231

Sir:

In accordance with the provisions of 37 C.F.R. § 1.192, Appellant submits the following:

I. REAL PARTY IN INTEREST

The real party in interest is the Assignee, Fuji Photo Film, Co. Ltd. An Assignment was filed in this application on August 2, 2000 and recorded at Reel 011016, Frame 0596.

II. RELATED APPEALS AND INTERFERENCES

To the best of the undersigned's knowledge, there are no related appeals or interferences.

III. STATUS OF CLAIMS

Claims 1-6 are presently pending in the application. Claims 1-6 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Yamazaki (USP 4,816,113).

IV. STATUS OF AMENDMENTS

Claims 1-4 were originally pending.

A first Non-Final Office Action (Paper No. 5) was mailed on August 1, 2001 rejecting claims 1-4 under 35 U.S.C. § 103(a) as being unpatentable over Yamazaki (US 4,816,113).

An Amendment was filed on February 1, 2002, adding new claims 5 and 6.

A Final Office Action (Paper No. 8) was mailed on May 14, 2002 rejecting the then pending claims 1-4 rejected under 35 U.S.C. § 103(a) as being unpatentable over Yamazaki (US 4,816,113).

A Notice of Appeal and a Petition for Extension of Time for three months were filed on November 14, 2002.

An Amendment responding to the final Office Action and requesting the addition of new claims 7 and 8 was filed on December 3, 2002.

An Advisory Action (Paper No. 12) was mailed on December 12, 2002, in which the Examiner maintained the rejection of claims 1-6 and denied entry of new claims 7 and 8.

V. SUMMARY OF THE INVENTION

The subject matter of the claimed invention relates to a method of forming a carbon layer using a vapor phase deposition technique, such a sputtering or chemical vapor deposition. Specification at page 1, first paragraph. The present invention has particular applicability when forming a carbon protective layer in a protective coating of a thermal recording head, but is also applicable to forming protective coatings on other articles, such as magnetic heads, molds for plastic, and tools. Specification at page 1, first paragraph; and page 7, lines 10-16.

Typical thermal recording heads include a glaze in which heating elements are arranged, for example, along one direction (the main scanning direction). In order to generate an image on thermal recording material, the thermal recording head is brought into contact with the thermal recording material, with the two members moved relative to each other in an auxiliary scanning direction that is perpendicular to the main scanning direction. Specification at page 2, lines 1-7. Energy is selectively applied to the heating elements of the respective pixels in the glaze in accordance with the image data to be recorded. Id. at lines 7-13.

In order to protect the heating elements (e.g., heat generating resistor(s) and associated electrodes) a protective coating is formed on the surface of the glaze, so that the protective coating makes actual contact with the recording material during thermal recording. Id. at lines 14-21.

There is a continuous increase in demand for better wear resistant protective coatings. For example, the trend in thermal imaging for medical applications is in the direction of higher quality images produced on rigid substrates where higher pressures and temperatures are used to create these images. Specification at page 3, lines 8-20.

Known techniques for protective coatings include the application of a carbon-based protective layer (carbon protective layer). Specification at page 3, line 26 to page 4, line 2. However, a serious problem encountered with conventional methods for manufacturing such protective layers is the existence of pinholes and/or cracks in the protective layer; thermal shocks or stress due to heating of the heating elements, stress due to differences in the coefficient of

expansion between the carbon protective layer and the neighboring layer, mechanical impact due to the presence of foreign matter lodged between the thermal material and the thermal head (glaze), and other factors that cause cracking or delamination. Specification at page 5, lines 1-9.

Appellants' invention addresses these problems by providing a carbon-based layer forming method by using of a vapor phase deposition technique such as sputtering or CVD, in which the method ensures that a high quality carbon layer having significantly reduced pinholes or cracks is produced. Specification at page 5, lines 17-22.

Referring to Fig. 1, for an example of an embodiment of the present invention applied to a thermal recording head, the thermal head 10 includes a glaze layer (heat-accumulating layer) 14 formed on the top of the substrate 12, a heater (heat generating resistor) 16 formed on the glaze layer 14, electrodes 18 formed on the heater 16, and a protective coating formed on the heating elements comprising the heater 16 and electrodes 18. Specification at page 8, lines 4-12.

The protective coating is illustrated as comprising three layers in this example: a lower protective layer 20 superposed on the heater 16 and electrodes 18, an intermediate protective layer 22 formed on the lower protective layer 20, and a carbon-based protective layer 24 formed onthe intermediate layer 22. Specification at page 8, lines 15-20.

A method of forming the carbon protective layer 24 is described as follows:

> Methods of forming the carbon protective layer 24 are not limited in any particular way and any known vapor phase deposition methods may be used in accordance with the composition of the carbon protective layer 24 to be formed. Preferred methods include sputtering, especially magnetron sputtering, and CVD, especially plasma-assisted

> CVD.
>
> The carbon layer forming method of the invention uses the vapor phase deposition technique to form a carbon-based carbon layer (carbon protective layer 24 in the illustrated case). The film deposition process is started after the content of particles having a particle size of 0.5 μm or more (hereinafter referred to as 0.5 μm-particle content) in the film deposition system is adjusted to 1000 particles/ft^3/min (cubic feet per minute = "cfm") or less, preferably 500 particles/cfm or less.
>
> By starting the film deposition process after the dust content in the film deposition system is adjusted t6 1000 particles/cfm in terms of the 0.5 μm-particle content, a high-quality carbon layer having significantly reduced pinholes or cracks can be formed. If the present invention is used for example to form the carbon protective layer 24 on the thermal head 10 as shown in FIG. 1, the carbon protective layer 24 has no cracking or delamination due to pinholes or cracks and can provide the thermal head 10 that exhibits high reliability over an extended period of time.

Specification at page 13, line 1 to page 14, line 1.

The method for adjusting the presence of 0.5 μm-particle content in the film deposition system down to 1000 particles/cfm or less is not necessarily limited to a particular way, but one such method involves removing the dust particles adhered to the chamber wall or other components in the film deposition system by cleaning the interior of the chamber of the film deposition system with a cloth that produces no more than 3000 particles/cfm, or preferably nor more than 1000 particles/cfm, or even 300 particles/cfm. In addition, the chamber can be pumped out after cleaning to remove floating particles. Specification at page 14, lines 9-21.

Appellants also disclose preferred ranges for the thickness of the various layers of the protective coating, including: a carbon layer having a thickness from 0.5 μm to 5 μm, an

intermediate layer having a thickness from 0.05 μm to 1 μm, and a lower protective layer having a thickness from 0.2 μm to 20 μm. Specification at page 16, lines 8-23. These ranges ensure good adhesion, shock absorption, and durability of the protective coating. Id.

Appellants disclose an illustrative comparison between: (a) the method of the present invention in which a cloth that produces 300 particles/cfm was used, and (b) one in which a cloth that produces 5000 particles/cfm. Specification at page 23, line 19 to page 32, line 6. In the method according to the present invention, the 0.5 μm-particle content in the chamber was measured to be 500 particles/cfm. Specification at page 28, lines 11-20. The defects of the protective layer thus formed included defects in size of no more than 10 μm. Specification at page 30, lines 21-24. Furthermore, when the thermal recording head having the protective coating formed in accordance with the invention as described above was used to record a solid image, damage, including delamination, was not observed, even after 25,000 sheets were recorded. Specification at page 31, lines 1-3.

On the other hand, in the case where the cloth that produces 5000 particles/cfm was used, the 0.5 μm-particle content in the chamber was measured to be significantly greater than 1000 particles/cfm. Specification at page 31, lines 14-20. Furthermore, in this latter case, the defects of the protective layer included defects in size up to about 100 μm. Id. at lines 21-24. When a solid image was recorded using on 5,000 sheets, delamination of the carbon protective layer 24 was confirmed in the defects having a size of 25 μm or more. Specification at page 31, line 25 to page 32, line 4.

VI. ISSUES

Whether claims 1-6 are unpatentable under 35 U.S.C. § 103(a) over Yamazaki (US 4,816,113).

VII. GROUPING OF CLAIMS

For the purposes of this appeal, claims 1-6 are believed to be separately patentable and, therefore, do not stand or fall together.

VIII. ARGUMENTS

In the first Office Action of August 1, 2001, the Examiner rejected claims 1-4 under 35 U.S.C. § 103(a) as being unpatentable over Yamazaki (USP 4,816,113). Since the Examiner reiterated this rejection in the final Office Action of May 14, 2002, Appellants discuss this first Office Action, and Appellants rebuttal, herein.

Specifically, in the first Office Action, the Examiner took the position that Yamazaki discloses all the features of claims 1-4, except that "Yamazaki doesn't describe adjusting the content of particles having a particle size of 0.5 μm or more to [sic] 1000 particles/ft^3/min or less (such as 500 or 100 particles/ft^3/min)." Office Action of August 1, 2001 at page 2.

The Examiner then took the position that Yamazaki's "steps of cleaning and [evacuating] the chamber to a high vacuum condition would reduce any undesirable products including particles having a particle size of 0.5 μm or more to 1000 particles/ft^3/min or less (such as 500 or 100 particles/ft^3/min)." Office Action of August 1, 2001 at page 2.

Appellants responded to the Examiner's position, and continue to maintain herein, that the Examiner acknowledges that Yamazaki does not explicitly disclose Appellants' claimed feature of "adjusting a content of particles having a particle size of 0.5 μm or more in a film deposition system of the carbon layer to 1000 particles/ft^3/min or less . . . ." Therefore, in order to reject claims 1-4 in view of Yamazaki, the Examiner must either argue that Yamazaki discloses this feature implicitly or inherently, or that this feature would have been obvious given the remaining disclosure of the reference.[1]

Appellants went on to set forth the law on inherency, noting that it is well settled that the fact that a certain result or characteristic may occur or be present in the prior art is not sufficient to establish the inherency of that result or characteristic. In re Rijckaert, 28 USPQ2d 1955, 1957 (Fed. Cir. 1993). "To establish inherency, the extrinsic evidence 'must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill. Inherency, however, may not be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient.'" In re Robertson, 49 USPQ2d 1949, 1950-51 (Fed. Cir. 1999). Moreover, "[i]n relying upon the theory of inherency, the examiner must provide a basis in fact and/or technical reasoning to reasonably support the determination that the allegedly

[1] Appellants also noted that, if the Examiner believed Yamazaki inherently or implicitly discloses the claimed feature in question, then the Examiner would have rejected at least claim 1 under 35 U.S.C. 102(b) as being anticipated by Yamazaki. Nevertheless, Appellants continue to maintain that under either theory of anticipation or obviousness, Yamazaki does not teach or suggest the feature in question.

inherent characteristic necessarily flows from the teachings of the applied prior art." Ex parte Levy, 17 USPQ2d 1461, 1464 (Bd. Pat. App. & Inter. 1990). Here, the Examiner has not presented any evidence or reasoning tending to show inherency.

Rather, as quoted above, the Examiner has merely stated that the "steps of cleaning and [evacuating] the chamber to a high vacuum condition would reduce any undesirable products including particles having a particle size of 0.5 μm or more to 1000 particles/ft^3/min or less (such as 500 or 100 particles/ft^3/min)." That is, the Examiner asserts that, according to the dry etching process disclosed in Yamazaki, the etching cleaning process performed after the formation of a film would necessarily result in the reduction of the content of particles having a particle size of 0.5 μm or more to 1000 particles/ft^3/min or less by the evacuation (to 1 x 10^{-6} Torr) after the dry etching process. Accordingly, Appellants maintain that the Examiner's conclusion is mere speculation and that there is no basis in fact or technical reasoning for reaching this conclusion.

Yamazaki discloses a method of removing undesirable carbon deposition on the inside of a reaction chamber for CVD without damaging the inside wall of the reaction chamber by dry etching the inside wall using oxygen. Yamazaki is completely silent with respect to adjusting the content of particles in the reaction chamber to be within a certain range. Indeed, this feature is unobvious in view of the reference, especially given that Yamazaki does not appreciate the importance of adjusting the content of 0.5 μm particles (or greater) to 1000 particles/ft^3/min in order to minimize the pinholes and cracks in, for example, the thermal recording head protective coating.

Moreover, in the dry etching process, a reactive gas is converted into a plasma gas and a negative bias voltage is applied to the object to be etched to thereby etch the object surface to a depth on the order of 0.1 to 1 μm.

1) Accordingly, a dry etching process would be required to be performed for a long time in order to remove foreign matters deposited to a thickness of about 10 to 100 μm to the inner wall of the chamber of such a film deposition apparatus as that to which the present invention is directed. It is practically impossible to take such measures.

2) Additionally, the dry etching process has a cleaning effect on the peripheral portion of the object to which a bias voltage required for the dry etching process can be applied. On the inner wall of the chamber of a film depositing apparatus that is important for good deposition results, however, the process has almost no cleaning effect because generally the electric potential of the inner wall of the chamber falls to ground potential.

3) Furthermore, the pressure of 1×10^{-6} Torr disclosed in Yamazaki is regarded to represent the quantity of a dilute gas in a vacuum. Particles existing in a solid form are still deposited to the inner wall of the chamber or falling on the chamber floor and their existence can not be represented by a pressure measurement. In addition, the residual solid particles may cause a production defect by rounding about the object when the apparatus is actuated.

According to the present invention, on the other hand, foreign matters or residues of small particle size deposited on the inner wall of the chamber are removed by wiping the inner wall surface for cleaning to thereby produce articles having less production defects, and as a

reference for the cleaning effect, the content of particles having a particle size of 0.5 μm or more is limited to 1000 particles/ft^3/min or less as measured by a particle counter.

The Examiner issued a final Office Action May 14, 2002, in which the Examiner reiterated verbatim the grounds of rejection set forth in the previous Office Action of August 1, 2001 for claims 1-4, and further rejected newly added claims 5 and 6 on the grounds that

> forming a thermal head having a 3 (sic) protective layers including a lower, intermediate, and carbon layer are well known to one skill (sic) in the art as described in page 8 of the specification. The thickness of each layer would have been obvious to determined (sic) through test runs in order to provide optimum thickness of each layer for protection of the thermal head with an anticipation of an expected result.

Office Action at page 3.

The Examiner specifically responded to Appellants' traversal arguments set forth in the February 1, 2002 Amendment as follows:

> Referring to applicant's argument that there is no evidence or reasoning tending to show inherency; there is no access to laboratory at the Office for examiner to carrying out the actual process; therefore, since the pressure of the chamber is similar to that of the claimed invention, it would provide similar result, such as reduce any undesirable products including particles having a particle size of 0.5 um or more to 1000 particles/ft3/min or less. Furthermore, applicant would have access to the laboratory to carry out the process, burden is on the applicant to show that under processing conditions described above, including the P of $1x10^{-6}$ Torr or a higher vacuum condition, the process doesn't provide a result of reducing particles having a particle size of 0.5 um or more to 1000 particles/ft3/min or less. Even if it is not the case, it would be obvious to one of ordinary skill in the art to have a clean chamber before depositing any layer; therefore, one skill in the art would remove any foreign particles or contaminations in the

> chamber so that the layer being deposited is not contaminated with other particles, or chemicals.
>
> In response to applicant's argument that the particles are reduced in order to minimize the pinholes and cracks in, the thermal recording head protective coating, the fact that applicant has recognized another advantage which would flow naturally from following the suggestion of the prior art cannot be the basis for patentability when the differences would otherwise be obvious. See *Ex parte Obiaya*, 227 USPQ 58, 60 (Bd. Pat. App. & Inter. 1985).
>
> Concerning applicant's providing of the distinctions between applicant and applied prior art, none of these points are in the claims. Although the claims are interpreted in light of the specification, limitations from the specification are not read into the claims. See *In re Van Geuns*, 988 F.2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993).

Final Office Action at pages 3-4 (emphasis added).

Appellants, again, respectfully disagree and maintain that Yamazaki would not have taught or suggested to one skilled in the art the features of method claims 1-6 for the reasons set forth above.

Appellants understand that the USPTO, and specifically the Examiner, is not required to carry out experimentation to prove a result. <u>However, in the case of Yamazaki, no such experimentation is needed on the part of the USPTO or the Appellants in order to establish that the process disclosed in this reference would not necessarily, or even likely, result in the conditions regarding the particle content and size recited in claim 1 of the present application.</u>

In particular, there is <u>no technical basis</u> from which the Examiner can assert that the content of particles having a size of 0.5 μm or more is 1000 particles/ft^3/min or less. As

explained above, the dry etching process disclosed in Yamazaki would not, in and of itself, result in the reduction of the content of particles having a particle size of 0.5 μm or more to 1000 particles/ft^3/min or less by the evacuation (to 1 x 10^{-6} Torr). To be sure, the pressure of 1 x 10^{-6} Torr disclosed in Yamazaki represents the quantity of a diluted gas in a vacuum, and does not correlate to the degree of the content of particles having a particle size of 0.5 μm or more to 1000 particles/ft^3/min or less. As Appellants explained above, particles existing in a solid form are still deposited to the inner wall of the chamber or fall on the chamber floor and their existence cannot be represented by a pressure measurement. Moreover, the residual solid particles may cause a production defect by rounding about the object when the apparatus is actuated.

Appellants should not be forced to go through the expense of disproving the Examiner's position, when the technical merits of this position are understood by those skilled in the art to be obviously invalid and mistaken.

Again, the Examiner acknowledges that Yamazaki does not describe adjusting the content of particles having a particle size of 0.5 μm or more in the chamber to 1000 particles/ft^3/min or less before forming the carbon layer. Nevertheless, the Examiner asserts that in Yamazaki, the steps of cleaning the interior of the chamber and evacuating the chamber to produce a high vacuum in the chamber would necessarily result in the reduction of the content of particles having a particle size of 0.5 μm or more in the chamber to 1000 particles/ft^3/min or less because a high vacuum of 1 x 10^{-6} Torr or more is produced in the chamber by cleaning the interior of the chamber and then evacuating the chamber. This is technically incorrect.

Particles, especially those having a particle size of 0.5 μm or more, are not molecules and, accordingly, such particles not only float in the chamber but also <u>adhere to the chamber walls or even pile up on the bottom of the chamber</u>. The particles adhering to the walls or piling up on the bottom can <u>not</u> be removed from the chamber by producing a high vacuum in the chamber, even if the molecules, particles, etc. floating in the chamber can be removed in this way. Moreover, the adsorption force for some of the adhered or piled-up particles is weakened due to the generation of a high vacuum, thereby becoming smaller than the suction force produced by the vacuum, such that some of the adhered or piled-up particles leave the walls or the bottom of the chamber, float within the chamber, and exit the interior of the chamber. Some of the adhered or piled-up particles may leave the walls or the bottom of the chamber to float in the chamber as a result of, for instance, the removal of water etc., <u>allowing the particles to adsorb to the walls or the bottom of the chamber by producing a high vacuum in the chamber</u>.

If a vacuum continues to be drawn until the adsorbing particles no more leave the walls or the bottom of the chamber, that is to say, a theoretically perfect vacuum is achieved, the content of the particles floating in the chamber <u>might</u> be reduced to 1000 particles/ft^3/min or less. Also in that case, however, the particles adsorbing to the walls or the bottom of the chamber will never be removed in this manner.

Furthermore, the vacuum which can be produced is not indefinite. Hence, it is <u>impossible</u> to reduce the content of the particles in the chamber including those adsorbing to the walls or the bottom of the chamber to 1000 particles/ft^3/min or less.

In summary, based on the correct technical understanding of the art and the disclosure of Yamazaki, the steps of cleaning in the interior of the chamber, evacuating the chamber, and producing a high vacuum in the chamber disclosed by Yamazaki can not result in the reduction of the content of particles having a particle size of 0.5 μm or more in the chamber to 1000 particles/ft^3/min or less.

The Examiner also contends that, regardless of whether the vacuum pressure disclosed in Yamazaki would necessarily result in the claimed feature, it would have been obvious to clean the chamber before depositing a layer. Assuming, for the sake of argument alone, that one skilled in the art would have cleaned the chamber prior to depositing a layer, it is not the case that the skilled artisan would have been aware of the criticality of doing so to the degree required by claim 1. As Appellants illustrate in their comparative examples set forth in their Specification at pages 23-32, when a cloth that produces 300 particles/cfm of dust was used to clean the inner wall surfaces of the vacuum chamber and followed by aspiration of the floating dust particles with a vacuum cleaner, the resulting thermal head had no signs of damage after 25,000 sheets were recorded. On the other hand, when a cloth that produces 5000 particles/cfm of dust was used to clean the inner wall surfaces of the vacuum chamber and followed by aspiration of the floating dust particles with a vacuum cleaner, or when the chamber was simply aspirated without first wiping with a cloth, the resulting thermal head showed signs of significant damage after recording only 5,000 sheets. This difference in performance clearly demonstrates the criticality

of Appellants' method for forming a carbon layer, as well as the unexpected superior results achieved therefrom.

The Examiner also takes the position that Appellants may not rely on the argument that the reduction of the particles is to minimize pinholes, since this advantage "would flow naturally" from the prior art teaching. Final Office Action of May 14, 2002 at page 4. However, as explained above, Yamazaki makes no teaching or suggestion that would limit the particle size as required by the present claims, and, therefore, one practicing the art of Yamazaki would not realize the advantages of this feature.

For all the foregoing reasons, claim 1, and dependent claims 2-6 are believed to be allowable over Yamazaki.

Furthermore, regarding claim 2, since the Examiner has not set forth a factual basis for his assertion that Yamazaki discloses adjusting the 0.5 μm-particle content to 1000 particles/ft^3/min as required by claim 1, the Examiner has also not established that Yamazaki discloses the threshold of 500 particles/ft^3/min recited in claim 2. Nor has the Examiner established that Yamazaki discloses the lower limit range of 50-100 particles/ft^3/min recited in claim 4.

The Examiner also argues that Appellants may not rely upon certain distinctions that are not captured by the present claims. However, at least with respect to claims 3-6, Appellants may rely on the requirement that the method is used to apply the coating on a thermal head used to

<u>perform thermal recording</u>. Therefore, Appellants may rely on any aspect of Yamazaki that would teach away from its use in the context of forming layers on a print head.

Moreover, regarding claim 6, in particular, the Examiner has <u>not</u> pointed to any prior art disclosure of the various thickness ranges recited in this claim. Rather, the Examiner has merely concluded, without more, that such ranges are a matter of routine experimentation. Appellants disagree. "A particular parameter must first be recognized as a result-effective variable . . . before the determination of the optimum or workable ranges of said variable might be characterized as routine experimentation." MPEP § 2144.05(b). The grounds of rejection are fatally flawed, since they do not address this threshold inquiry at all. Moreover, as explained in Appellants' specification at page 16, these ranges ensure good adhesion, shock absorption, and durability of the protective coating.

In view of the major differences over the applied reference, Appellants respectfully request that the rejection of claims 1-6 be reversed and the application passed to issue forthwith.

The present Brief on Appeal is being filed in triplicate. Unless a check is submitted herewith for the fee required under 37 C.F.R. §1.192(a) and 1.17(c), please charge said fee to Deposit Account No. 19-4880.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,

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Date: January 14, 2003

APPENDIX

CLAIMS 1-6 ON APPEAL:

1. A method of forming a carbon layer by vapor phase deposition, comprising the steps of:

adjusting a content of particles having a particle size of 0.5 μm or more in a film deposition system of the carbon layer to 1000 particles/ft^3/min or less; and then

starting a film deposition process of the carbon layer.

2. The method according to claim 1, wherein said content of the particles having the particle size of 0.5 μm or more is reduced to 500 particles/ft^3/min.

3. The method according to claim 1, wherein said carbon layer is formed as a protective coating on a thermal head performing thermal recording.

4. The method according to claim 1, wherein a lower limit of said content of the particles having the particle size of 0.5 μm or more ranges between 50 particles/ft^3/min and 100 particles/ft^3/min.

5. The method of forming a carbon layer by vapor phase deposition according to claim 3, wherein said carbon layer is formed on top of an intermediate layer and the intermediate layer is

formed on top of a lower protective layer such that the thermal head has a protective coating of a three-layer structure.

6. The method of forming a carbon layer by vapor phase deposition according to claim 5, wherein said carbon layer has a thickness from 0.5 μm to 5 μm, said intermediate layer has a thickness from 0.05 μm to 1 μm, and said lower protective layer has a thickness from 0.2 μm to 20 μm.